heffron transportation inc

# TECHNICAL MEMORANDUM

**Project:** ISD High School #4 / Elementary School #17

**Subject:** Site Access Analysis

**Date:** June 10, 2020

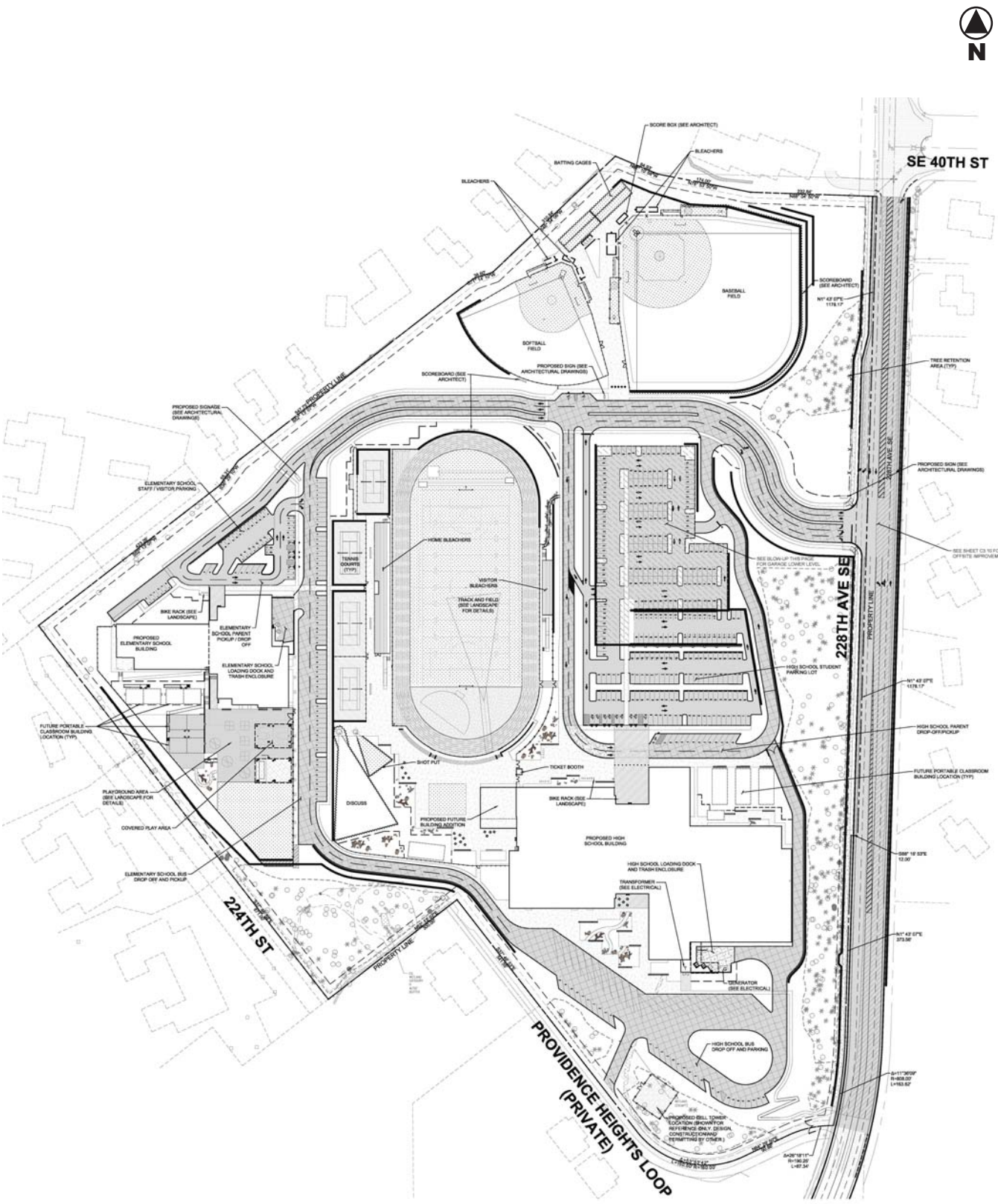
**Authors:** Jennifer Barnes, Associate Principal, P.E.
Tod McBryan, Principal, P.E.

## 1. Introduction

This memorandum presents site access analysis for a new high school (High School #4) and new elementary school (Elementary School #17) proposed by the Issaquah School District (ISD). The site is located within Issaquah, but the proposed access intersection is within Sammamish and traffic operational analysis of the site access intersection was completed according to requirements established by the City of Sammamish. Please contact Jennifer Barnes at (206) 324-3623 with any questions.

ISD proposes to co-locate a new elementary school (serving grades pre-kindergarten through 5) and a new high school (serving grades 9 through 12) on a property located west of 228th Avenue SE and north of SE 43rd Way. The elementary school is planned for an enrollment capacity of 744 students with about 75 faculty and staff; the high school is planned for an enrollment capacity of 1,823 students with about 150 faculty and staff. The schools are planned to be completed and partially occupied by Fall 2022, and fully occupied by Fall 2023. Analysis presented in this memorandum was completed for future 2024 conditions with the schools operating at full capacity and taking into account traffic from development growth unrelated to the project. Peak hour trips forecast to be generated by the two schools are based upon methods described in the *Trip Generation and Distribution – Updated* technical memorandum (Heffron Transportation, June 9, 2020) prepared for the project.

The proposed site plan is shown on **Figure 1**. Analysis presented in this memorandum finds that a single site access driveway, built to the configuration described herein, would be sufficient to accommodate projected future peak traffic volumes with both schools operating at capacity. The analysis methods and results are described in the following sections.




*Source: AHBL, June 9, 2020*

# High School #4
# Elementary #17

Figure 1

**Preliminary Site Plan**

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# 2. Traffic Volumes

The following sections describe the methods applied to forecast the background (without-project) and with-project volumes.

## 2.1. Existing Volumes

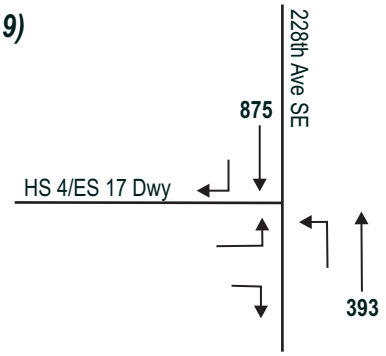
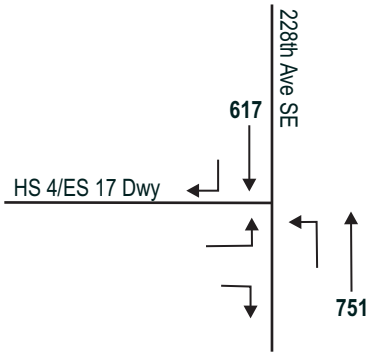
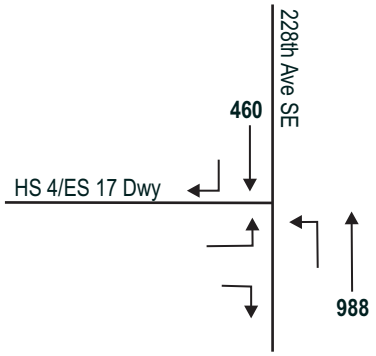
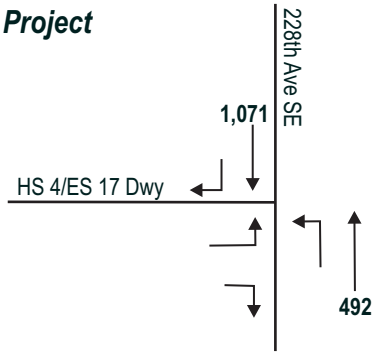
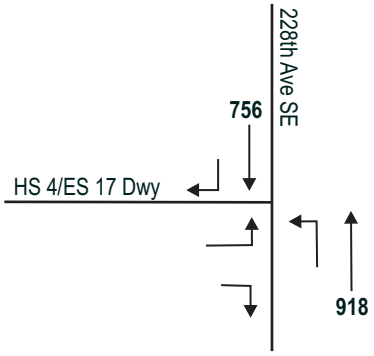
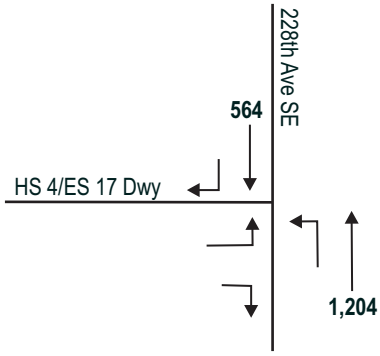
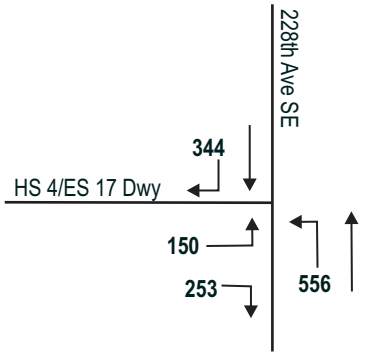
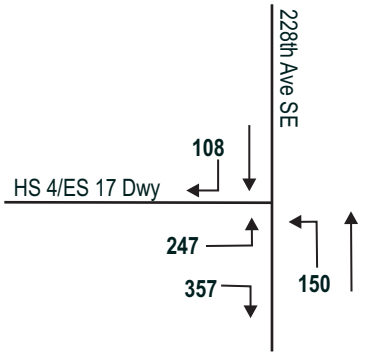
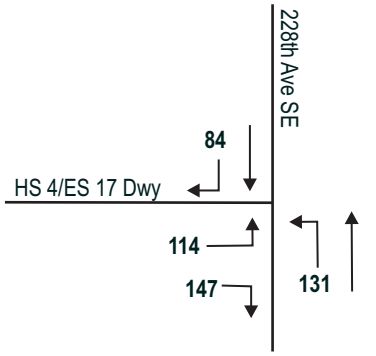
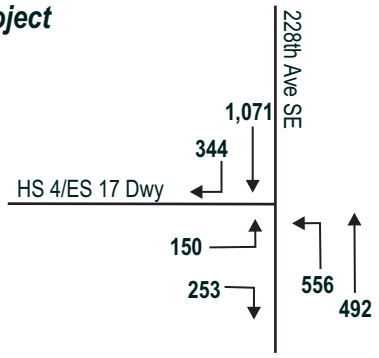
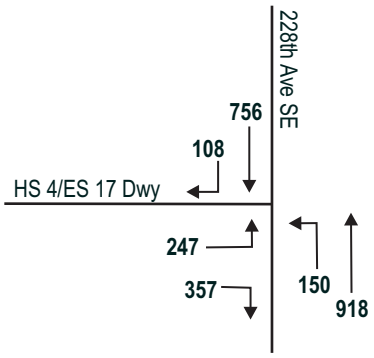
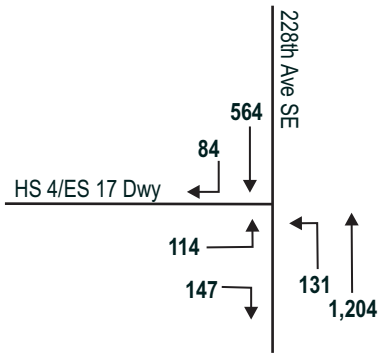
Due to the Covid-19 pandemic and associated state-wide school closures initiated by Governor Inslee in March 2020, it was not possible to collect representative new traffic data for this analysis. Therefore, all analyses were based on traffic data collected in May 2019 by the City of Sammamish. **Figure 2** shows turning movement volumes for existing (2019) conditions, and forecast 2024 conditions with and without the proposed school project. Traffic count data sheets are provided in **Appendix A**.

For the morning and commuter PM peak hours, existing traffic volumes on 228th Avenue SE adjacent to the site were obtained directly from City of Sammamish turning movement counts collected immediately north of the project site at the 228th Avenue SE / SE 40th Street intersection. Sammamish Municipal Code (SMC) §14A.05.010 defines the period from 7:00 to 8:00 A.M. as the model morning peak hour, and the period from 4:45 to 5:45 P.M. as the model PM peak hour. As described in the *Trip Generation and Distribution – Updated* technical memorandum, the schools' combined AM peak hour is offset from the City-defined peak hour by 15 minutes—starting at 7:15 A.M. instead of 7:00 A.M. However, to ensure analysis of the potential worst-case condition, the school's peak morning volumes were assumed to overlap the City's morning peak. The commuter PM peak hour volumes reflect the hour beginning at 4:45 P.M., consistent with the City code.

The afternoon peak hour is an analysis period unique to school projects, and is not generally counted as part of regular City data collection efforts. Typically for school projects, new traffic counts would be conducted during the afternoon peak hour at all analysis intersections. However, due to conditions caused by the Covid-19 pandemic and noted above, it was not possible to conduct new representative traffic counts. Instead, existing afternoon peak hour volumes were estimated by applying factors derived from 24-hour count volumes collected by the City of Sammamish in May 2019.

The afternoon volumes were derived by reviewing and comparing hourly counts conducted on 228th Avenue SE, south of SE 32nd Street. This location is about 3,000 feet north of the planned driveway location; it was the closest available daily count and was determined to provide a reasonable comparison of afternoon and evening counts because there are no major intersections between the count location and the site. Comparison of volumes in each direction between the 3:00 to 4:00 P.M. (the school's expected afternoon peak hour) and 5:00 to 6:00 (approximate commuter PM peak) found that the afternoon peak hour volume on 228th Avenue SE, is about 76% of the commuter PM peak hour volume in the northbound direction, and about 134% of the commuter PM peak hour volume in the southbound direction. These factors were applied to the commuter PM peak hour volumes in each respective direction to estimate the afternoon peak hour volumes.

N

| | Morning Peak Hour | Afternoon Peak Hour | Commuter PM Peak Hour |
|---|---|---|---|
| *Existing (2019)* |  |  |  |
| *2024 Without Project* |  |  |  |
| *Project Trips* |  |  |  |
| *2024 With Project* |  |  |  |



**High School #4**
**Elementary #17**

Figure 2
**Site Access Driveway Volumes**
**Combined AM, Afternoon, & PM Peak Hours**

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## 2.2. Forecast 2024 Without-Project Volumes

To estimate year 2024 background volumes (without the proposed project), traffic resulting from regional development growth, as well as traffic expected to be generated by pipeline development projects (permitted or under construction, but expected to be complete and occupied by the future analysis year) in the vicinity of the site, was added to the existing volumes.

Future baseline volumes were estimated according to direction provided by the City of Sammamish.[1] Based upon City direction, a growth rate of 4% was applied to the 2019 volumes, compounded annually over a 5-year period, to estimate 2024 volumes. This reflects traffic volume growth expected to be generated by new regional development unrelated to the proposed project. Trips generated by the following two pipeline development projects were also added:

- ISD's Elementary School #16, located at Issaquah-Pine Lake Road/Klahanie Boulevard;[2] and
- The new Sammamish Town Center (Phase 1) project at the southwest corner of 228th Avenue SE / SE 4th Street. [3]

Figure 2 shows the forecast 2024 without-project traffic volumes at the proposed site access intersection.

## 2.3. Forecast 2024 With-Project Volumes

To calculate year 2024 volumes with the project, the trip generation estimates developed for the schools at full capacity (described in detail in the *Trip Generation and Distribution – Updated* technical memorandum, and also shown on Figure 2) were added to the 2024-without-project volumes. Figure 2 shows the forecast 2024 with-project traffic volumes at the proposed site access intersection.

# 3. Traffic Signal Warrant Analysis

Due to the relatively high traffic volumes on 228th Avenue SE, it is anticipated that signalization would be required at the schools' site access intersection. Therefore, traffic signal warrant analysis was performed according to guidelines published in the *Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways.*[4] Hourly traffic volumes for a full day, needed to complete the signal warrant analysis, were estimated as follows.

1. Background volumes on 228th Avenue SE were assumed to reflect an hourly profile similar to the City's 24-hour traffic count conducted to the south of SE 32nd Street in May 2019, but factored up to reflect the 2024-without-project volumes as described above.
2. Volumes generated by Elementary School #17 were assumed to reflect an hourly profile similar to that of Sunny Hills Elementary, based upon 24-hour counts conducted at the Sunny Hills Elementary driveways on Tuesday, October 1, and Thursday, October 3, 2019.
3. Volumes generated by High School #4 were assumed to reflect an hourly profile similar to that of Skyline High School, based upon 24-hour counts conducted at the Skyline High School driveways on Tuesday, October 1, and Thursday, October 3, 2019.
4. The combined school-generated trips were added to the 2024 without-project background traffic volumes to estimate total future volumes with the project.

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1 Email from Steven Chen, Traffic Engineering Manager, City of Sammamish, March 10, 2020.
2 Jake Traffic Engineering, Inc., Elementary School #16, Traffic Impact Analysis Revised, September 18, 2019.
3 Transpo Group, Traffic Impact Analysis, Sammamish Town Center Phase 1, October 2019.
4 US Department of Transportation, Federal Highway Administration, 2009.

The MUTCD states, "*A traffic control signal should not be installed unless one or more of the factors described in this section are met*." The nine warrants for traffic signal installation are listed as follows:

- Warrant 1 – Eight-Hour Vehicular Volume (minimum volumes over eight hours)
- Warrant 2 – Four-Hour Vehicular Volume (minimum volumes over four hours)
- Warrant 3 – Peak Hour (minimum volume over a one-hour period)
- Warrant 4 – Pedestrian Volume
- Warrant 5 – School Crossing (adequacy of gaps near school crossing location)
- Warrant 6 – Coordinated Signal System (platooning for one-way or two-way streets)
- Warrant 7 – Crash Experience (number and type of accidents)
- Warrant 8 – Roadway Network (for organized traffic flow networks)
- Warrant 9 – Intersection Near a Grade Crossing

If the posted speed limit or the 85$^{th}$-percentile speed on the major street exceeds 40 mph, the MUTCD allows a "70% factor" to be applied to Warrants 1 through 3, which reduces the warrant thresholds to 70% of the volumes that are otherwise applied to an intersection. The posted speed limit on 228$^{th}$ Avenue SE is 40 mph, which is at but does not exceed this threshold. Determination of the 85$^{th}$ percentile speed can be made through speed measurements; but were not provided by the City. To provide a conservative analysis of the above warrants, the unadjusted thresholds were applied.

The volumes used to assess the three warrants for 2024 with-project conditions are summarized in **Table 1**. As shown, Warrants 1B, 2, and 3 are expected to be met for conditions with the project. Additionally, it is likely that with the high peak hour volumes through the intersection, the requirements for Warrant 5 (school crossing) could also be met. These results indicate that expected traffic conditions with the project would meet the MUTCD warrants for installation of a traffic signal. If a speed study determined that application of the 70% threshold were appropriate, a greater number of hours would meet the warrant conditions, but would not change the overall conclusion since warrants are expected to be met at the unadjusted thresholds.

Table 1. Signal Warrant Analysis Summary – 2024 Conditions With Project

| Hour Beginning | Major Street Volume (both directions) [a] | Minor Street Volume [a] | Vehicle Volume Warrant Requirements Met? | | | |
|---|---|---|---|---|---|---|
| | 228th Avenue SE | HS 4 / ES 17 Driveway | 1A | 1B | 2 | 3 |
| 12:00 A.M. | 58 | 1 | N | N | N | N |
| 1:00 A.M. | 29 | 0 | N | N | N | N |
| 2:00 A.M. | 16 | 0 | N | N | N | N |
| 3:00 A.M. | 39 | 1 | N | N | N | N |
| 4:00 A.M. | 119 | 1 | N | N | N | N |
| 5:00 A.M. | 323 | 2 | N | N | N | N |
| 6:00 A.M. | 982 | 12 | N | N | N | N |
| 7:00 A.M. | 2,381 | 268 | Y | Y | Y | Y |
| 8:00 A.M. | 1,963 | 292 | Y | Y | Y | Y |
| 9:00 A.M. | 1,686 | 156 | N | Y | Y | N |
| 10:00 A.M. | 1,136 | 78 | N | N | N | N |
| 11:00 A.M. | 1,180 | 92 | N | N | N | N |
| 12:00 P.M. | 1,237 | 70 | N | N | N | N |
| 1:00 P.M. | 1,274 | 74 | N | N | N | N |
| 2:00 P.M. | 1,430 | 139 | | Y | Y | N |
| 3:00 P.M. | 1,921 | 604 | Y | Y | Y | Y |
| 4:00 P.M. | 1,924 | 272 | Y | Y | Y | Y |
| 5:00 P.M. | 1,965 | 247 | Y | Y | Y | Y |
| 6:00 P.M. | 1,753 | 111 | N | Y | N | N |
| 7:00 P.M. | 1,152 | 65 | N | N | N | N |
| 8:00 P.M. | 816 | 128 | N | N | N | N |
| 9:00 P.M. | 600 | 147 | N | N | N | N |
| 10:00 P.M. | 284 | 10 | N | N | N | N |
| 11:00 P.M. | 164 | 5 | N | N | N | N |
| | | Hours Met? | 5 | 8 | 7 | 5 |
| | | Hours Required | 8 | 8 | 4 | 1 |
| | | Warrant Met? | No | Yes | Yes | Yes |

*Source: Heffron Transportation, Inc., June 2020, using warrants and thresholds from the MUTCD, US Department of Transportation, Federal Highway Administration, 2009.*

Based upon the results of the signal warrant analysis, installation of a traffic signal at the 228th Avenue SE / School Driveway is recommended and has been incorporated into the proposal. The operational effects of the project with this recommended access configuration are described in the following section.

## 4. Intersection Configuration and Operating Parameters

Based upon the operational analysis completed for the 228th Avenue SE / School Driveway intersection, the recommended channelization and signalization includes the following elements.

- **School Access Driveway: East Leg** – In the eastbound direction (the exit from the school site), the school driveway would have double-left turn lanes and a single right-turn lane approaching 228th Avenue SE. It would have two westbound (entry) lanes.
- **228th Avenue SE: North Leg** – In the southbound direction, 228th Avenue SE would have two through lanes, and a right-turn lane into the school site. Analysis indicates that a storage length of about 260 feet would be needed to accommodate the 95th-percentile queue for the southbound-to westbound right-turn movement entering the site. Northbound, 228th Avenue SE would have two through lanes.
- **228th Avenue SE: South Leg** – In the northbound direction, 228th Avenue SE would have an exclusive left-turn lane, a center lane with changeable signal configuration that allows shared through-left movements during the morning peak hour and through-only movements during other times of day, and an exclusive thru-lane; there is a similar to configuration at NE 124th Street/100th Avenue NE in Kirkland (see **Figure 3**). The analysis indicates that the northbound left-turn lane would need to be about 390 feet long to accommodate the forecast 95th percentile queue. Southbound, 228th Avenue SE would have two through lanes.
- **Right-Turn Overlap Phases** – The signal would have overlap phases that would allow eastbound right turns out of the site and southbound right turns into the site to occur concurrently with the northbound and eastbound left-turn movements, respectively.

Figure 3. Example Shared Left-Thru Lane – NE 124th Street / 100th Avenue NE, Kirkland


*Source: Google Maps, Image Date, August 2019.*

# 5. Traffic Operations with the Project

## 5.1. Level of Service

Traffic operations are evaluated based on level-of-service (LOS), which is a qualitative measure used to characterize intersection operating conditions. Six letter designations, "A" through "F," are used to define level of service. LOS A is the best and represents good traffic operations with little or no delay to motorists. LOS F is the worst and indicates poor traffic operations with long delays.

The City of Sammamish has adopted a standard of LOS D for most intersections that include Principal Arterials (such as 228th Avenue SE). However, for intersections with three approach lanes in any direction, a standard of LOS E is assigned.[5]

Levels of service for the site access intersection were determined using methodologies established in the *Highway Capacity Manual (HCM), 6th Edition.*[6] **Appendix B** summarizes level of service thresholds and definitions for signalized intersections. All level-of-service calculations were performed using the *Synchro 10.3 (Build 122)* traffic operations analysis software. The *Synchro* reports for the level of service analysis presented in this memorandum are also provided in Appendix B. It should be noted that this analysis also assumes signalization of the 228th Avenue SE / SE 40th Street intersection to the north, and that the two signals would be coordinated. The coordination assumption constrains the optimization of signal timings at the site access driveway, and therefore reflects a more conservative (worst-case) estimate of operations at the driveway. While the City of Sammamish *Comprehensive Plan* identifies future capacity improvement at the 228th Avenue SE / SE 40th Street intersection,[7] and preliminary analysis completed for the project has also found that improvements would be needed, the type of improvement has not yet been confirmed. If improvements consist of measures other than signalization, optimization of the signal timings at the site access driveway intersection would be less constrained.

Table 2 summarizes forecast 2024 levels of service for the three peak hour conditions with the proposed project and recommended intersection configuration. As shown, the intersection is projected to operate at LOS D overall during the morning peak hour, LOS B during the afternoon peak hour, and LOS A during the commuter PM peak hour. These results show that with both schools operating at capacity, the intersection would operate within the City's adopted level-of-service standards during all times of day.

Table 2. Level of Service at 228th Ave SE / Site Access Driveway – 2024 Conditions With-Project

| | Morning Peak Hour (7:15 – 8:15 A.M.) | | Afternoon Peak Hour (3:00 – 4:00 P.M.) | | Commuter PM Peak Hour (4:45 – 5:45 P.M.) | |
|---|---|---|---|---|---|---|
| | LOS [a] | Delay [b] | LOS | Delay | LOS | Delay |
| Overall Intersection | D | 45.7 | B | 19.4 | A | 9.5 |
| Worst Movement | E [c] | 64.4 | C | 28.1 | E [d] | 58.0 |

*Source: Heffron Transportation, Inc., June 2020.*

*a. LOS = Level of service.*

*b. Delay = Average seconds of delay per vehicle.*

*c. Worst movement is northbound left-turn; all other movements projected to operate at LOS D or better.*

*d. Worst movement is eastbound left-turn; all other movements projected to operate at LOS A.*

5 City of Sammamish, Comprehensive Plan, Background Transportation Information, Amended September 18, 2018.
6 Transportation Research Board, 2016.
7 City of Sammamish, 2018.

## 5.2. Queuing Analysis

Vehicle queuing at the approaches of the 228th Avenue SE / School Driveway intersection was evaluated using the *SimTraffic* microsimulation software. Conditions were modeled applying the forecast with-project traffic volumes described above.

It is important to note that *Synchro* models, as described in the previous section, are deterministic; this means that they apply formulas for capacity analysis that result in one specific answer or result. The formulas are based on years of research on driving conditions, and are established in the *Highway Capacity Manual*.[8] The thresholds to determine levels of service (LOS A through LOS F) described in the previous section are based upon these formulas—as are the LOS standards adopted by the City—so *Synchro* models provide the appropriate means to determine intersection level of service and potential project impacts to those operating conditions.

The *Synchro* analysis is differentiated from *SimTraffic* models, which are stochastic. This means that they include a random element that simulates driver behavior. Multiple model runs, performed with a defined set of conditions, generally produce similar results over the course of an analysis period (e.g. a peak hour); however, they will not necessarily match one another exactly, since individual vehicles react differently under a given set of conditions. Simulation models are most appropriate for evaluating the interaction of different elements in a transportation system. For the analysis presented in this memorandum, *SimTraffic* models were developed to evaluate the vehicle queues that would be generated at the intersection approaches during each of the analysis peak hours. Peak hour queuing summary reports, based upon the average of six model runs for each analysis period, are provided in **Appendix C**. As previously described, the queuing analysis determined that a storage length of about 260 feet would be needed to accommodate the 95th-percentile queue for the southbound right-turn movement, and a storage length of about 390 feet would be needed to accommodate the 95th-percentile queue for the northbound left-turn movement.

# 6. Summary

The access analysis presented above found that a single access driveway, built to the following configuration would accommodate the proposal:

1) Full signalization (forecast traffic volumes would meet at least three MUTCD warrants);
2) Double-left turn lanes and a single right-turn lane in the eastbound direction with two westbound entry lanes;
3) Two through lanes and a right-turn lane into the school site in the southbound direction and two northbound lanes on 228th Avenue SE north of the access intersection; and
4) An exclusive left-turn lane, a center lane with changeable signal phasing that allows shared through-left movements during the morning peak and through-only movements during other times of day, an exclusive thru-lane in the northbound direction, and two southbound through movements south of the access intersection.

With the traffic control and configuration described above, peak hour operations for the overall intersection are projected to be LOS D during the morning peak hour, LOS B during the afternoon peak hour, and LOS A during the commuter PM peak hour. All movements would operate at LOS E or better during the peak hours, with most operating at LOS D or better. These results show that with both schools operating at full capacity, the site access intersection would operate within the City's adopted level of service standard during all times of day.

[8] Transportation Research Board, 2016.

PRJ19-00008 Attachment 064

# APPENDIX A

# TRAFFIC COUNTS

**June 10, 2020**

Prepared for: **City of Sammamish**

*Traffic Count Consultants, Inc.*

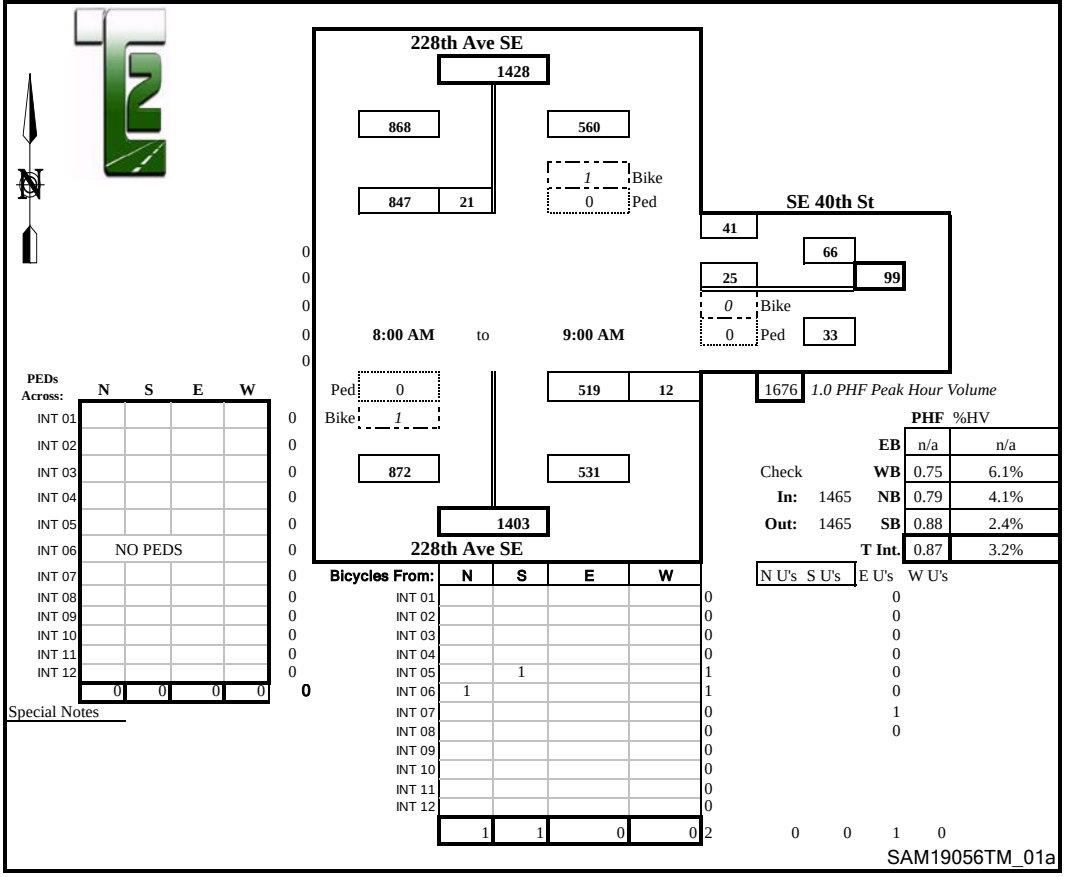
Phone: (253) 770-1407 FAX: (253) 770-1411 E-Mail: Team@TC2inc.com

WBE/DBE

**Intersection:** 228th Ave SE & SE 40th St **Date of Count:** Thurs 5/02/2019

**Location:** Sammamish, Washington **Checked By:** Jess

| Time Interval Ending at | From North on (SB) 228th Ave SE | | | | From South on (NB) 228th Ave SE | | | | From East on (WB) SE 40th St | | | | From West on (EB) 0 | | | | Interval Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | L | S | R | T | L | S | R | T | L | S | R | T | L | S | R | |
| 7:15 A | 3 | 2 | 191 | 0 | 3 | 0 | 99 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 295 |
| 7:30 A | 2 | 2 | 186 | 0 | 4 | 0 | 93 | 2 | 1 | 9 | 0 | 7 | 0 | 0 | 0 | 0 | 299 |
| 7:45 A | 4 | 2 | 238 | 0 | 3 | 0 | 97 | 2 | 0 | 5 | 0 | 14 | 0 | 0 | 0 | 0 | 358 |
| 8:00 A | 2 | 5 | 205 | 0 | 5 | 0 | 108 | 1 | 2 | 12 | 0 | 29 | 0 | 0 | 0 | 0 | 360 |
| 8:15 A | 5 | 8 | 214 | 0 | 2 | 0 | 88 | 2 | 3 | 6 | 0 | 16 | 0 | 0 | 0 | 0 | 334 |
| 8:30 A | 4 | 5 | 206 | 0 | 1 | 0 | 114 | 3 | 1 | 5 | 0 | 10 | 0 | 0 | 0 | 0 | 343 |
| 8:45 A | 7 | 4 | 185 | 0 | 8 | 0 | 168 | 1 | 0 | 8 | 0 | 3 | 0 | 0 | 0 | 0 | 369 |
| 9:00 A | 5 | 4 | 242 | 0 | 11 | 0 | 149 | 6 | 0 | 6 | 0 | 12 | 0 | 0 | 0 | 0 | 419 |
| 9:15 A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9:30 A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9:45 A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10:00 A | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Survey | 32 | 32 | 1667 | 0 | 37 | 0 | 916 | 17 | 7 | 53 | 0 | 92 | 0 | 0 | 0 | 0 | 2777 |
| Peak Hour: 8:00 AM to 9:00 AM | | | | | | | | | | | | | | | | | |
| Total | 21 | 21 | 847 | 0 | 22 | 0 | 519 | 12 | 4 | 25 | 0 | 41 | 0 | 0 | 0 | 0 | 1465 |
| Approach | 868 | | | | 531 | | | | 66 | | | | 0 | | | | 1465 |
| %HV | 2.4% | | | | 4.1% | | | | 6.1% | | | | n/a | | | | 3.2% |
| PHF | 0.88 | | | | 0.79 | | | | 0.75 | | | | n/a | | | | 0.87 |




Special Notes

SAM19056TM_01a

Prepared for: **City of Sammamish**

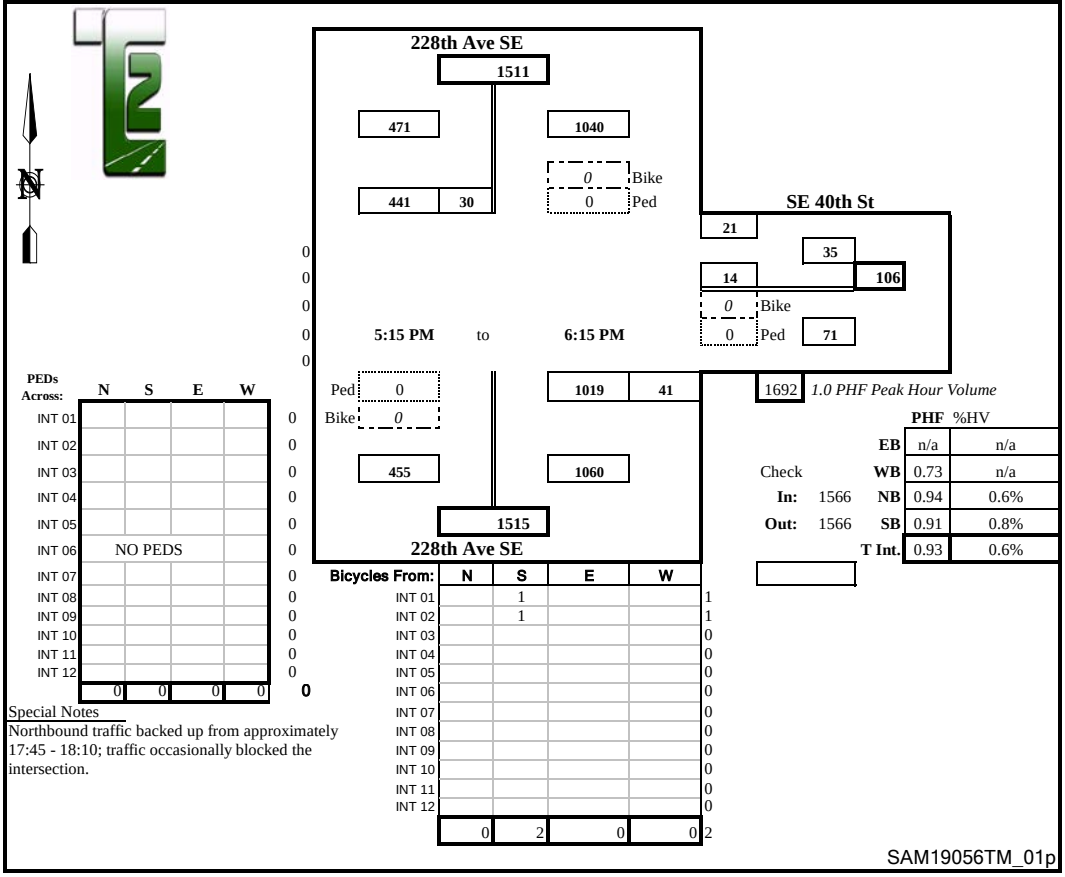
*Traffic Count Consultants, Inc.*

Phone: (253) 770-1407 FAX: (253) 770-1411 E-Mail: Team@TC2inc.com

WBE/DBE

**Intersection:** 228th Ave SE & SE 40th St
**Location:** Sammamish, Washington
**Date of Count:** Thurs 5/02/2019
**Checked By:** Jess

| Time Interval Ending at | From North on (SB) 228th Ave SE | | | | From South on (NB) 228th Ave SE | | | | From East on (WB) SE 40th St | | | | From West on (EB) 0 | | | | Interval Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T | L | S | R | T | L | S | R | T | L | S | R | T | L | S | R | |
| 4:45 P | 1 | 6 | 117 | 0 | 2 | 0 | 218 | 5 | 0 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 351 |
| 5:00 P | 1 | 6 | 118 | 0 | 3 | 0 | 235 | 5 | 1 | 3 | 0 | 6 | 0 | 0 | 0 | 0 | 373 |
| 5:15 P | 1 | 7 | 130 | 0 | 0 | 0 | 218 | 1 | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 362 |
| 5:30 P | 1 | 8 | 104 | 0 | 1 | 0 | 259 | 13 | 0 | 1 | 0 | 5 | 0 | 0 | 0 | 0 | 390 |
| 5:45 P | 1 | 6 | 97 | 0 | 3 | 0 | 252 | 5 | 0 | 6 | 0 | 5 | 0 | 0 | 0 | 0 | 371 |
| 6:00 P | 0 | 6 | 123 | 0 | 0 | 0 | 270 | 12 | 0 | 5 | 0 | 7 | 0 | 0 | 0 | 0 | 423 |
| 6:15 P | 2 | 10 | 117 | 0 | 2 | 0 | 238 | 11 | 0 | 2 | 0 | 4 | 0 | 0 | 0 | 0 | 382 |
| 6:30 P | 0 | 6 | 138 | 0 | 0 | 0 | 223 | 11 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 385 |
| 6:45 P | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7:00 P | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7:15 P | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7:30 P | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Survey | 7 | 55 | 944 | 0 | 11 | 0 | 1913 | 63 | 1 | 21 | 0 | 41 | 0 | 0 | 0 | 0 | 3037 |
| Peak Hour: | 5:15 PM to 6:15 PM | | | | | | | | | | | | | | | | |
| Total | 4 | 30 | 441 | 0 | 6 | 0 | 1019 | 41 | 0 | 14 | 0 | 21 | 0 | 0 | 0 | 0 | 1566 |
| Approach | 471 | | | | 1060 | | | | 35 | | | | 0 | | | | 1566 |
| %HV | 0.8% | | | | 0.6% | | | | n/a | | | | n/a | | | | 0.6% |
| PHF | 0.91 | | | | 0.94 | | | | 0.73 | | | | n/a | | | | 0.93 |




| | PHF | %HV |
|---|---|---|
| EB | n/a | n/a |
| WB | 0.73 | n/a |
| NB | 0.94 | 0.6% |
| SB | 0.91 | 0.8% |
| T Int. | 0.93 | 0.6% |

Check In: 1566 Out: 1566

Special Notes

Northbound traffic backed up from approximately 17:45 - 18:10; traffic occasionally blocked the intersection.

SAM19056TM_01p

# TRAFFIC COUNT CONSULTANTS, INC.



**SAMMAMISH, WASHINGTON**
**228TH AVE SE S/O**
**SE 32ND ST**
**LOC# 13 V SAM19056TM**

## Traffic Data Gathering

**Team@tc2inc.com**
**(253) 770-1407**

**Page 1**

**Site Code: 13**

**Date Start: 16-May-19**
**Date End: 22-May-19**

| | 16-May-19 | | Fri | | Sat | | Sun | | Mon | | Tue | | Wed | | Week Average | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Start Time | NB | SB | NB | SB | NB | SB | NB | SB | NB | SB | NB | SB | NB | SB | NB | SB |
| 12:00 AM | 37 | 17 | 41 | 25 | 73 | 48 | 67 | 49 | 38 | 31 | 28 | 25 | 30 | 29 | 45 | 32 |
| 01:00 | 16 | 9 | 20 | 11 | 36 | 27 | 38 | 20 | 23 | 10 | 13 | 15 | 7 | 11 | 22 | 15 |
| 02:00 | 9 | 9 | 8 | 6 | 12 | 10 | 19 | 18 | 12 | 5 | 2 | 7 | 7 | 4 | 10 | 8 |
| 03:00 | 14 | 16 | 13 | 16 | 16 | 12 | 15 | 19 | 13 | 25 | 16 | 21 | 10 | 21 | 14 | 19 |
| 04:00 | 43 | 59 | 38 | 49 | 27 | 25 | 27 | 25 | 35 | 60 | 33 | 68 | 45 | 65 | 35 | 50 |
| 05:00 | 79 | 179 | 72 | 166 | 32 | 55 | 28 | 37 | 63 | 197 | 91 | 189 | 75 | 182 | 63 | 144 |
| 06:00 | 246 | 513 | 223 | 443 | 77 | 167 | 44 | 106 | 246 | 486 | 244 | 534 | 276 | 501 | 194 | 393 |
| 07:00 | 488 | 849 | **512** | 770 | 214 | 242 | 176 | 141 | **501** | 771 | **551** | 815 | 490 | 807 | 419 | 628 |
| 08:00 | **526** | **917** | 464 | **919** | 318 | 469 | 242 | 285 | 440 | **890** | 454 | **900** | 502 | **869** | 421 | 750 |
| 09:00 | 461 | 880 | 479 | 848 | 424 | 586 | 286 | 483 | 467 | 882 | 447 | 863 | **529** | 822 | 442 | **766** |
| 10:00 | 359 | 544 | 431 | 600 | 559 | 671 | 357 | 586 | 404 | 497 | 413 | 547 | 446 | 643 | 424 | 584 |
| 11:00 | 472 | 481 | 481 | 553 | **650** | **698** | **494** | **614** | 420 | 500 | 427 | 503 | 429 | 579 | **482** | 561 |
| 12:00 PM | 513 | 492 | 528 | 562 | 651 | **697** | 565 | 588 | 459 | 477 | 484 | 474 | 529 | 560 | 533 | 550 |
| 01:00 | 524 | 516 | 543 | 514 | 665 | 679 | 594 | **591** | 485 | 523 | 482 | 510 | 575 | 515 | 553 | 550 |
| 02:00 | 566 | 526 | 625 | 596 | 630 | 653 | 573 | 559 | 559 | 483 | 592 | 488 | 586 | 483 | 590 | 541 |
| 03:00 | 765 | **678** | 771 | **670** | 641 | 619 | 599 | 501 | 691 | **631** | 722 | **684** | 615 | 639 | 686 | **632** |
| 04:00 | 871 | 628 | 870 | 621 | **675** | 576 | **633** | 512 | 837 | 543 | 841 | 641 | 868 | **678** | 799 | 600 |
| 05:00 | **964** | 515 | **884** | 589 | 579 | 626 | 574 | 499 | **952** | 493 | **1004** | 504 | 915 | 508 | **839** | 533 |
| 06:00 | 890 | 521 | 825 | 509 | 525 | 464 | 456 | 339 | 911 | 451 | 964 | 496 | **965** | 472 | 791 | 465 |
| 07:00 | 583 | 348 | 517 | 392 | 416 | 299 | 398 | 270 | 526 | 266 | 589 | 359 | 578 | 392 | 515 | 332 |
| 08:00 | 370 | 221 | 445 | 330 | 330 | 222 | 340 | 250 | 347 | 227 | 407 | 235 | 384 | 342 | 375 | 261 |
| 09:00 | 290 | 167 | 375 | 239 | 319 | 172 | 190 | 135 | 231 | 199 | 283 | 183 | 317 | 264 | 286 | 194 |
| 10:00 | 150 | 90 | 256 | 146 | 264 | 164 | 111 | 83 | 129 | 55 | 149 | 83 | 155 | 84 | 173 | 101 |
| 11:00 | 95 | 53 | 162 | 83 | 177 | 93 | 59 | 48 | 66 | 38 | 81 | 49 | 69 | 51 | 101 | 59 |
| Lane | 9331 | 9228 | 9583 | 9657 | 8310 | 8274 | 6885 | 6758 | 8855 | 8740 | 9317 | 9193 | 9402 | 9521 | 8812 | 8767 |
| Day | 18559 | | 19240 | | 16584 | | 13643 | | 17595 | | 18510 | | 18923 | | 17579 | |
| AM Peak | 8:00 | 8:00 | 7:00 | 8:00 | 11:00 | 11:00 | 11:00 | 11:00 | 7:00 | 8:00 | 7:00 | 8:00 | 9:00 | 8:00 | 11:00 | 9:00 |
| Vol. | 526 | 917 | 512 | 919 | 650 | 698 | 494 | 614 | 501 | 890 | 551 | 900 | 529 | 869 | 482 | 766 |
| PM Peak | 17:00 | 15:00 | 17:00 | 15:00 | 16:00 | 12:00 | 16:00 | 13:00 | 17:00 | 15:00 | 17:00 | 15:00 | 18:00 | 16:00 | 17:00 | 15:00 |
| Vol. | 964 | 678 | 884 | 670 | 675 | 697 | 633 | 591 | 952 | 631 | 1004 | 684 | 965 | 678 | 839 | 632 |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Comb. Total | 18559 | | 19240 | | 16584 | | 13643 | | 17595 | | 18510 | | 18923 | | 17579 | |

| | | | | |
|---|---|---|---|---|
| ADT | **ADT** | **17579** | AADT | 17579 |
| | **AWDT** | **18565** | | |

PRJ19-00008 Attachment 064

# APPENDIX B

# LEVEL OF SERVICE DEFINITIONS & LOS CALCULATION SHEETS

**June 10, 2020**

Levels of service (LOS) are qualitative descriptions of traffic operating conditions. These levels of service are designated with letters ranging from LOS A, which is indicative of good operating conditions with little or no delay, to LOS F, which is indicative of stop-and-go conditions with frequent and lengthy delays. Levels of service for this analysis were developed using procedures presented in the *Highway Capacity Manual, Sixth Edition* (Transportation Research Board, 2016).

Level of service for signalized intersections is defined in terms of average delay for all vehicles that travel through the intersection. Delay can be a cause of driver discomfort, frustration, inefficient fuel consumption, and lost travel time. Specifically, level-of-service criteria are stated in terms of the average delay per vehicle in seconds. Delay is a complex measure and is dependent on a number of variables including: number and type of vehicles by movement, intersection lane geometry, signal phasing, the amount of green time allocated to each phase, transit stops and parking maneuvers. Table B-1 shows the level of service criteria for signalized intersections from the *Highway Capacity Manual, Sixth Edition.*

Table B-1. Level of Service for Signalized Intersections

| Level of Service | Average Control Delay Per Vehicle |
|---|---|
| A | ≤ 10 seconds |
| B | > 10 – 20 seconds |
| C | > 20 – 35 seconds |
| D | > 35 – 55 seconds |
| E | > 55 – 80 seconds |
| F | > 80 seconds |

*Source: Transportation Research Board, Highway Capacity Manual, Exhibit 19.8, 2016.*

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 150 | 253 | 556 | 492 | 1071 | 344 |
| Future Volume (vph) | 150 | 253 | 556 | 492 | 1071 | 344 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 11 | 10 | 10 | 10 | 11 | 10 |
| Storage Length (ft) | 0 | 200 | 370 | | | 250 |
| Storage Lanes | 2 | 1 | 1 | | | 0 |
| Taper Length (ft) | 50 | | 50 | | | |
| Lane Util. Factor | 0.97 | 1.00 | 0.91 | 0.91 | 0.95 | 1.00 |
| Ped Bike Factor | | 0.96 | 0.99 | 1.00 | | 0.96 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | 0.950 | | 0.950 | 0.979 | | |
| Satd. Flow (prot) | 3255 | 1449 | 1474 | 3071 | 3421 | 1396 |
| Flt Permitted | 0.950 | | 0.950 | 0.979 | | |
| Satd. Flow (perm) | 3255 | 1395 | 1467 | 3065 | 3421 | 1341 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | | 7 | | | | 22 |
| Link Speed (mph) | 25 | | | 40 | 40 | |
| Link Distance (ft) | 431 | | | 1211 | 380 | |
| Travel Time (s) | 11.8 | | | 20.6 | 6.5 | |
| Confl. Peds. (#/hr) | | 20 | 20 | | | 20 |
| Confl. Bikes (#/hr) | | | | | | 5 |
| Peak Hour Factor | 0.63 | 0.63 | 0.63 | 0.92 | 0.92 | 0.63 |
| Heavy Vehicles (%) | 4% | 4% | 4% | 2% | 2% | 8% |
| Adj. Flow (vph) | 238 | 402 | 883 | 535 | 1164 | 546 |
| Shared Lane Traffic (%) | | | 47% | | | |
| Lane Group Flow (vph) | 238 | 402 | 468 | 950 | 1164 | 546 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 22 | | | 10 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 10 | | | 10 | 10 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.04 | 1.09 | 1.09 | 1.09 | 1.04 | 1.09 |
| Turning Speed (mph) | 15 | 12 | 15 | | | 12 |
| Number of Detectors | 3 | 3 | 3 | 4 | 4 | 3 |
| Detector Template | Sea25 | Sea25 | Sea25 | Sea40 | Sea40 | Sea25 |
| Leading Detector (ft) | 111 | 111 | 111 | 236 | 236 | 111 |
| Trailing Detector (ft) | 2 | 2 | 2 | 2 | 2 | 2 |
| Detector 1 Position(ft) | 2 | 2 | 2 | 2 | 2 | 2 |
| Detector 1 Size(ft) | 6 | 6 | 6 | 6 | 6 | 6 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 16 | 16 | 16 | 16 | 16 | 16 |
| Detector 2 Size(ft) | 6 | 6 | 6 | 6 | 6 | 6 |
| Detector 2 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 3 Position(ft) | 105 | 105 | 105 | 85 | 85 | 105 |
| Detector 3 Size(ft) | 6 | 6 | 6 | 6 | 6 | 6 |
| Detector 3 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 3 Channel | | | | | | |
| Detector 3 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 4 Position(ft) | | | | 230 | 230 | |
| Detector 4 Size(ft) | | | | 6 | 6 | |
| Detector 4 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 4 Channel | | | | | | |
| Detector 4 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | pm+ov | Split | NA | NA | pm+ov |
| Protected Phases | 4 | 2 | 2 | 2 | 6 | 4 |
| Permitted Phases | | 4 | | | | 6 |
| Detector Phase | 4 | 4 | 2 | 2 | 6 | 6 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 | 7.0 |
| Minimum Split (s) | 33.0 | 12.0 | 12.0 | 12.0 | 33.0 | 33.0 |
| Total Split (s) | 33.0 | 42.0 | 42.0 | 42.0 | 45.0 | 33.0 |
| Total Split (%) | 27.5% | 35.0% | 35.0% | 35.0% | 37.5% | 27.5% |
| Maximum Green (s) | 28.0 | 37.0 | 37.0 | 37.0 | 40.0 | 28.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lead/Lag | | | | | | |
| Lead-Lag Optimize? | | | | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Recall Mode | None | Min | Min | Min | C-Min | None |
| Walk Time (s) | 10.0 | | | | 10.0 | 10.0 |
| Flash Dont Walk (s) | 18.0 | | | | 18.0 | 18.0 |
| Pedestrian Calls (#/hr) | 20 | | | | 20 | 20 |
| Act Effct Green (s) | 23.7 | 65.0 | 41.3 | 41.3 | 40.0 | 63.7 |
| Actuated g/C Ratio | 0.20 | 0.54 | 0.34 | 0.34 | 0.33 | 0.53 |
| v/c Ratio | 0.37 | 0.52 | 0.92 | 0.90 | 1.02 | 0.75 |
| Control Delay | 42.5 | 17.5 | 64.4 | 50.6 | 55.0 | 23.6 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 42.5 | 17.5 | 64.4 | 50.6 | 55.0 | 23.6 |
| LOS | D | B | E | D | D | C |
| Approach Delay | 26.8 | | | 55.1 | 45.0 | |
| Approach LOS | C | | | E | D | |

Intersection Summary

Area Type: Other
Cycle Length: 120
Actuated Cycle Length: 120
Offset: 0 (0%), Referenced to phase 6:SBT, Start of 1st Green, Master Intersection
Natural Cycle: 120

Control Type: Actuated-Coordinated
Maximum v/c Ratio: 1.02
Intersection Signal Delay: 45.7
Intersection LOS: D
Intersection Capacity Utilization 76.3%
ICU Level of Service D
Analysis Period (min) 15

Splits and Phases: 2: 228th Ave SE & HS4-ES17 Dwy

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 247 | 357 | 150 | 918 | 756 | 108 |
| Future Volume (vph) | 247 | 357 | 150 | 918 | 756 | 108 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 11 | 10 | 10 | 10 | 11 | 10 |
| Storage Length (ft) | 0 | 200 | 370 | | | 250 |
| Storage Lanes | 2 | 1 | 1 | | | 0 |
| Taper Length (ft) | 50 | | 50 | | | |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Ped Bike Factor | | 0.97 | 1.00 | | | 0.97 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | 0.950 | | 0.950 | | | |
| Satd. Flow (prot) | 3224 | 1436 | 1532 | 3303 | 3421 | 1370 |
| Flt Permitted | 0.950 | | 0.226 | | | |
| Satd. Flow (perm) | 3224 | 1391 | 363 | 3303 | 3421 | 1326 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | | 42 | | | | 140 |
| Link Speed (mph) | 25 | | | 40 | 40 | |
| Link Distance (ft) | 435 | | | 1211 | 381 | |
| Travel Time (s) | 11.9 | | | 20.6 | 6.5 | |
| Confl. Peds. (#/hr) | | 20 | 20 | | | 20 |
| Confl. Bikes (#/hr) | | | | | | 5 |
| Peak Hour Factor | 0.69 | 0.69 | 0.77 | 0.92 | 0.92 | 0.77 |
| Heavy Vehicles (%) | 5% | 5% | 10% | 2% | 2% | 10% |
| Adj. Flow (vph) | 358 | 517 | 195 | 998 | 822 | 140 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 358 | 517 | 195 | 998 | 822 | 140 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 22 | | | 10 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 10 | | | 10 | 10 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.04 | 1.09 | 1.09 | 1.09 | 1.04 | 1.09 |
| Turning Speed (mph) | 15 | 12 | 15 | | | 12 |
| Number of Detectors | 3 | 3 | 3 | 4 | 4 | 3 |
| Detector Template | Sea25 | Sea25 | Sea25 | Sea40 | Sea40 | Sea25 |
| Leading Detector (ft) | 111 | 111 | 111 | 236 | 236 | 111 |
| Trailing Detector (ft) | 2 | 2 | 2 | 2 | 2 | 2 |
| Detector 1 Position(ft) | 2 | 2 | 2 | 2 | 2 | 2 |
| Detector 1 Size(ft) | 6 | 6 | 6 | 6 | 6 | 6 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 16 | 16 | 16 | 16 | 16 | 16 |
| Detector 2 Size(ft) | 6 | 6 | 6 | 6 | 6 | 6 |
| Detector 2 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 3 Position(ft) | 105 | 105 | 105 | 85 | 85 | 105 |
| Detector 3 Size(ft) | 6 | 6 | 6 | 6 | 6 | 6 |
| Detector 3 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 3 Channel | | | | | | |
| Detector 3 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 4 Position(ft) | | | | 230 | 230 | |
| Detector 4 Size(ft) | | | | 6 | 6 | |
| Detector 4 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 4 Channel | | | | | | |
| Detector 4 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | pm+ov | D.P+P | NA | NA | pm+ov |
| Protected Phases | 4 | 5 | 5 | 2 | 6 | 4 |
| Permitted Phases | | 4 | 6 | | | 6 |
| Detector Phase | 4 | 4 | 5 | 2 | 6 | 6 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 7.0 | 7.0 | 7.0 | 10.0 | 10.0 | 7.0 |
| Minimum Split (s) | 33.0 | 12.0 | 12.0 | 15.0 | 33.0 | 33.0 |
| Total Split (s) | 36.0 | 17.0 | 17.0 | 54.0 | 37.0 | 36.0 |
| Total Split (%) | 40.0% | 18.9% | 18.9% | 60.0% | 41.1% | 40.0% |
| Maximum Green (s) | 31.0 | 12.0 | 12.0 | 49.0 | 32.0 | 31.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lead/Lag | | Lead | Lead | | Lag | |
| Lead-Lag Optimize? | | Yes | Yes | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Recall Mode | None | None | None | C-Min | C-Min | None |
| Walk Time (s) | 10.0 | | | | 10.0 | 10.0 |
| Flash Dont Walk (s) | 18.0 | | | | 18.0 | 18.0 |
| Pedestrian Calls (#/hr) | 20 | | | | 20 | 20 |
| Act Effct Green (s) | 29.0 | 39.1 | 46.0 | 51.0 | 35.9 | 64.9 |
| Actuated g/C Ratio | 0.32 | 0.43 | 0.51 | 0.57 | 0.40 | 0.72 |
| v/c Ratio | 0.34 | 0.82 | 0.62 | 0.53 | 0.60 | 0.14 |
| Control Delay | 23.8 | 28.1 | 19.8 | 13.9 | 21.4 | 1.7 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Delay | 23.8 | 28.1 | 19.8 | 13.9 | 21.4 | 1.7 |
| LOS | C | C | B | B | C | A |
| Approach Delay | 26.4 | | | 14.9 | 18.6 | |
| Approach LOS | C | | | B | B | |

Intersection Summary

Area Type: Other
Cycle Length: 90
Actuated Cycle Length: 90
Offset: 0 (0%), Referenced to phase 2:NBT and 6:NBSB, Start of 1st Green, Master Intersection
Natural Cycle: 80

Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.82
Intersection Signal Delay: 19.4 Intersection LOS: B
Intersection Capacity Utilization 59.1% ICU Level of Service B
Analysis Period (min) 15
Description: Background vols approximated from 2018 count @ SE40th St

Splits and Phases: 2: 228th Ave SE & HS4-ES17 Dwy

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Lane Configurations | | | | | | |
| Traffic Volume (vph) | 114 | 147 | 131 | 1204 | 564 | 84 |
| Future Volume (vph) | 114 | 147 | 131 | 1204 | 564 | 84 |
| Ideal Flow (vphpl) | 1900 | 1900 | 1900 | 1900 | 1900 | 1900 |
| Lane Width (ft) | 11 | 10 | 10 | 10 | 11 | 10 |
| Storage Length (ft) | 0 | 200 | 370 | | | 250 |
| Storage Lanes | 2 | 1 | 1 | | | 0 |
| Taper Length (ft) | 50 | | 50 | | | |
| Lane Util. Factor | 0.97 | 1.00 | 1.00 | 0.95 | 0.95 | 1.00 |
| Ped Bike Factor | | 0.96 | 0.99 | | | 0.96 |
| Frt | | 0.850 | | | | 0.850 |
| Flt Protected | 0.950 | | 0.950 | | | |
| Satd. Flow (prot) | 3319 | 1478 | 1668 | 3303 | 3421 | 1492 |
| Flt Permitted | 0.950 | | 0.401 | | | |
| Satd. Flow (perm) | 3319 | 1413 | 696 | 3303 | 3421 | 1426 |
| Right Turn on Red | | Yes | | | | Yes |
| Satd. Flow (RTOR) | | 169 | | | | 97 |
| Link Speed (mph) | 25 | | | 40 | 40 | |
| Link Distance (ft) | 435 | | | 1211 | 383 | |
| Travel Time (s) | 11.9 | | | 20.6 | 6.5 | |
| Confl. Peds. (#/hr) | | 20 | 20 | | | 20 |
| Confl. Bikes (#/hr) | | | | | | 5 |
| Peak Hour Factor | 0.87 | 0.87 | 0.87 | 0.92 | 0.92 | 0.87 |
| Heavy Vehicles (%) | 2% | 2% | 1% | 2% | 2% | 1% |
| Adj. Flow (vph) | 131 | 169 | 151 | 1309 | 613 | 97 |
| Shared Lane Traffic (%) | | | | | | |
| Lane Group Flow (vph) | 131 | 169 | 151 | 1309 | 613 | 97 |
| Enter Blocked Intersection | No | No | No | No | No | No |
| Lane Alignment | Left | Right | Left | Left | Left | Right |
| Median Width(ft) | 22 | | | 10 | 0 | |
| Link Offset(ft) | 0 | | | 0 | 0 | |
| Crosswalk Width(ft) | 10 | | | 10 | 10 | |
| Two way Left Turn Lane | | | | | | |
| Headway Factor | 1.04 | 1.09 | 1.09 | 1.09 | 1.04 | 1.09 |
| Turning Speed (mph) | 15 | 12 | 15 | | | 12 |
| Number of Detectors | 3 | 3 | 3 | 4 | 4 | 3 |
| Detector Template | Sea25 | Sea25 | Sea25 | Sea40 | Sea40 | Sea25 |
| Leading Detector (ft) | 111 | 111 | 111 | 236 | 236 | 111 |
| Trailing Detector (ft) | 2 | 2 | 2 | 2 | 2 | 2 |
| Detector 1 Position(ft) | 2 | 2 | 2 | 2 | 2 | 2 |
| Detector 1 Size(ft) | 6 | 6 | 6 | 6 | 6 | 6 |
| Detector 1 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 1 Channel | | | | | | |
| Detector 1 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Queue (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 1 Delay (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 2 Position(ft) | 16 | 16 | 16 | 16 | 16 | 16 |
| Detector 2 Size(ft) | 6 | 6 | 6 | 6 | 6 | 6 |
| Detector 2 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |

| Lane Group | EBL | EBR | NBL | NBT | SBT | SBR |
|---|---|---|---|---|---|---|
| Detector 2 Channel | | | | | | |
| Detector 2 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 3 Position(ft) | 105 | 105 | 105 | 85 | 85 | 105 |
| Detector 3 Size(ft) | 6 | 6 | 6 | 6 | 6 | 6 |
| Detector 3 Type | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex | Cl+Ex |
| Detector 3 Channel | | | | | | |
| Detector 3 Extend (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Detector 4 Position(ft) | | | | 230 | 230 | |
| Detector 4 Size(ft) | | | | 6 | 6 | |
| Detector 4 Type | | | | Cl+Ex | Cl+Ex | |
| Detector 4 Channel | | | | | | |
| Detector 4 Extend (s) | | | | 0.0 | 0.0 | |
| Turn Type | Prot | pm+ov | D.P+P | NA | NA | pm+ov |
| Protected Phases | 4 | 5 | 5 | 2 | 6 | 4 |
| Permitted Phases | | 4 | 6 | | | 6 |
| Detector Phase | 4 | 4 | 5 | 2 | 6 | 6 |
| Switch Phase | | | | | | |
| Minimum Initial (s) | 7.0 | 7.0 | 7.0 | 10.0 | 10.0 | 7.0 |
| Minimum Split (s) | 33.0 | 12.0 | 12.0 | 15.0 | 33.0 | 33.0 |
| Total Split (s) | 40.0 | 21.0 | 21.0 | 110.0 | 89.0 | 40.0 |
| Total Split (%) | 26.7% | 14.0% | 14.0% | 73.3% | 59.3% | 26.7% |
| Maximum Green (s) | 35.0 | 16.0 | 16.0 | 105.0 | 84.0 | 35.0 |
| Yellow Time (s) | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 | 4.0 |
| All-Red Time (s) | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Lost Time Adjust (s) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Total Lost Time (s) | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| Lead/Lag | | Lead | Lead | | Lag | |
| Lead-Lag Optimize? | | Yes | Yes | | | |
| Vehicle Extension (s) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Recall Mode | None | None | None | C-Min | C-Min | None |
| Walk Time (s) | 10.0 | | | | 10.0 | 10.0 |
| Flash Dont Walk (s) | 18.0 | | | | 18.0 | 18.0 |
| Pedestrian Calls (#/hr) | 20 | | | | 20 | 20 |
| Act Effct Green (s) | 20.0 | 29.7 | 115.0 | 120.0 | 105.3 | 125.3 |
| Actuated g/C Ratio | 0.13 | 0.20 | 0.77 | 0.80 | 0.70 | 0.84 |
| v/c Ratio | 0.30 | 0.40 | 0.25 | 0.50 | 0.26 | 0.08 |
| Control Delay | 58.0 | 8.3 | 5.5 | 6.8 | 7.7 | 0.9 |
| Queue Delay | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 |
| Total Delay | 58.0 | 8.3 | 5.5 | 6.9 | 7.7 | 0.9 |
| LOS | E | A | A | A | A | A |
| Approach Delay | 30.0 | | | 6.7 | 6.7 | |
| Approach LOS | C | | | A | A | |

Intersection Summary

Area Type: Other
Cycle Length: 150
Actuated Cycle Length: 150
Offset: 0 (0%), Referenced to phase 2:NBT and 6:NBSB, Start of 1st Green, Master Intersection
Natural Cycle: 80

Control Type: Actuated-Coordinated
Maximum v/c Ratio: 0.50
Intersection Signal Delay: 9.5 Intersection LOS: A
Intersection Capacity Utilization 57.4% ICU Level of Service B
Analysis Period (min) 15
Description: Background vols approximated from 2018 count @ SE40th St

Splits and Phases: 2: 228th Ave SE & HS4-ES17 Dwy

PRJ19-00008 Attachment 064

# APPENDIX C

# SIMTRAFFIC REPORTS

**June 10, 2020**

## 2: 228th Ave SE & HS4-ES17 Dwy Performance by movement

| Movement | EBL | EBR | NBL | NBT | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Denied Del/Veh (s) | 0.2 | 0.6 | 0.8 | 0.4 | 0.1 | 0.1 | 0.3 |
| Total Del/Veh (s) | 42.0 | 14.1 | 43.9 | 39.9 | 31.3 | 12.4 | 32.0 |

## Intersection: 2: 228th Ave SE & HS4-ES17 Dwy

| Movement | EB | EB | EB | NB | NB | NB | SB | SB | SB | B6 | B6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Directions Served | L | L | R | L | LT | T | T | T | R | T | T |
| Maximum Queue (ft) | 173 | 144 | 202 | 422 | 568 | 458 | 391 | 397 | 302 | 72 | 83 |
| Average Queue (ft) | 80 | 40 | 95 | 217 | 290 | 226 | 276 | 288 | 179 | 4 | 7 |
| 95th Queue (ft) | 151 | 114 | 182 | 391 | 491 | 386 | 394 | 411 | 361 | 44 | 47 |
| Link Distance (ft) | | | | | 1151 | 1151 | 302 | 302 | | 126 | 126 |
| Upstream Blk Time (%) | | | | | | | 5 | 5 | 1 | 0 | 0 |
| Queuing Penalty (veh) | | | | | | | 37 | 38 | 0 | 0 | 1 |
| Storage Bay Dist (ft) | | | 200 | 390 | | | | | 260 | | |
| Storage Blk Time (%) | | 0 | 1 | 0 | 3 | | | 11 | 0 | | |
| Queuing Penalty (veh) | | 0 | 2 | 2 | 14 | | | 39 | 3 | | |

## 2: 228th Ave SE & HS4-ES17 Dwy Performance by movement

| Movement | EBL | EBR | NBL | NBT | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Denied Del/Veh (s) | 0.3 | 0.7 | 1.2 | 0.6 | 0.0 | 0.0 | 0.4 |
| Total Del/Veh (s) | 27.7 | 11.8 | 18.8 | 24.7 | 12.0 | 1.9 | 18.0 |

## Intersection: 2: 228th Ave SE & HS4-ES17 Dwy

| Movement | EB | EB | EB | NB | NB | NB | SB | SB | SB |
|---|---|---|---|---|---|---|---|---|---|
| Directions Served | L | L | R | L | T | T | T | T | R |
| Maximum Queue (ft) | 193 | 174 | 210 | 244 | 365 | 382 | 194 | 216 | 65 |
| Average Queue (ft) | 102 | 57 | 107 | 85 | 150 | 157 | 104 | 103 | 16 |
| 95th Queue (ft) | 172 | 134 | 194 | 241 | 383 | 393 | 177 | 181 | 49 |
| Link Distance (ft) | | | | | 1149 | 1149 | 304 | 304 | |
| Upstream Blk Time (%) | | | | | | | | | |
| Queuing Penalty (veh) | | | | | | | | | |
| Storage Bay Dist (ft) | | | 200 | 390 | | | | | 260 |
| Storage Blk Time (%) | | 0 | 2 | 0 | 4 | | | | |
| Queuing Penalty (veh) | | 0 | 4 | 0 | 7 | | | | |

## 2: 228th Ave SE & HS4-ES17 Dwy Performance by movement

| Movement | EBL | EBR | NBL | NBT | SBT | SBR | All |
|---|---|---|---|---|---|---|---|
| Denied Del/Veh (s) | 0.1 | 0.2 | 1.6 | 0.3 | 0.0 | 0.0 | 0.3 |
| Total Del/Veh (s) | 54.3 | 7.3 | 13.2 | 21.4 | 7.6 | 1.1 | 17.4 |

## Intersection: 2: 228th Ave SE & HS4-ES17 Dwy

| Movement | EB | EB | EB | NB | NB | NB | SB | SB | SB |
|---|---|---|---|---|---|---|---|---|---|
| Directions Served | L | L | R | L | T | T | T | T | R |
| Maximum Queue (ft) | 158 | 126 | 97 | 204 | 429 | 439 | 154 | 175 | 46 |
| Average Queue (ft) | 81 | 38 | 48 | 68 | 175 | 183 | 61 | 62 | 9 |
| 95th Queue (ft) | 146 | 109 | 81 | 233 | 428 | 434 | 131 | 141 | 33 |
| Link Distance (ft) | | | | | 1149 | 1149 | 306 | 306 | |
| Upstream Blk Time (%) | | | | | | | | | |
| Queuing Penalty (veh) | | | | | | | | | |
| Storage Bay Dist (ft) | | | 200 | 390 | | | | | 260 |
| Storage Blk Time (%) | | | | | 5 | | | 0 | |
| Queuing Penalty (veh) | | | | | 6 | | | 0 | |